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THE EFFECTS OF SMOKING ON PERIPHERAL MOVEMENT DETECTION AND TIME ESTIMATION PERFORMANCE

FINAL REPORT

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Previous research has shown that smoking and nicotine may have an effect on visual functions. Several studies were conducted to determine if smoking and smoking deprivation would have an effect on the detection of movement by peripheral vision and to determine the effects of smoking and smoking deprivation on time estimation performance. It was found that under levels of low illumination, nonsmokers had a significantly larger peripheral field, that deprived smokers were better than smokers in detecting movement in the

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20. Abstract (Continued)

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periphery of the visual field and that subjects on a velocity estimation task who had been deprived of smoking performed better than smokers. In a study concerned with relationships between nicotine level and performance, high nicotine smokers performed better on a movement detection task than low nicotine or deprived smokers. On a time estimation task, it was found that nicotine had some adverse effects but, under other conditions, actually improved performance.

A number of investigations over the years have dealt with the effects of nicotine and smoking on various visual functions. For example, studies have been conducted in such areas as sensitivity to light (De Gaspare and Boles-Carenini, 1952; McFarland, 1953; Powell, 1938; Vignal, 1964), adaptation (Bohne, 1962; Sheard, 1946; Troemel, Davis, and Hendley, 1951; Vignal, 1964), accommodation (Powell, 1938), and accommodation and convergence (Wilmer and Berens, 1919). Other functions that have been studied include the size of the angioscotoma (Fink, 1946), flicker fusion frequency (Barlow and Baar, 1967; Fabricant and Rose, 1951; Larson, Finnegan and Haag, 1950; Larson, Haag and Silvette, 1961; Larson and Silvette, 1968; Warwick and Eysenck, 1963), foveal acuity (Wilmer and Berens, 1919), para-foveal acuity (Bohne, 1962), visual search performance (Johnston, 1966), and target detection under night driving conditions (Johansson and Jansson, 1965). A comprehensive review of experimental and clinical studies on the effects of smoking on vision may be found in Larson, Haag and Silvette (1961, 1968).

Recent investigations by Johnston (1965a, 1965b) and in this laboratory (Krippner and Heimstra, 1969) have been concerned with the effects of smoking on peripheral visual acuity. Johnston (1965a), while investigating the relationship between peripheral visual acuity and visual search performance, noticed that smoking appeared to reduce the size of the visual fields of the observers. In another study (Johnston, 1965b), it was noted that abstinence from smoking increased the size of the visual form field and that smoking resulted in a reverse effect.

It should be noted that the findings relating to smoking and peripheral visual functions have been based on static visual acuity tests. While it is of interest that a relationship does exist, the practical significance of these findings is open to question since little is known about the functional importance of static peripheral acuity. Whether the human organism "receives" and makes use of static peripheral visual information, and the degree to which he uses this information in dealing with his environment, is presently unknown. However, of considerable potential importance from a practical point of view is the possible relationship between smoking and dynamic peripheral functions such as movement detection. In many man-machine systems, such as F/W and R/W aircraft the ability of the operator to detect movements peripherally, e.g., another aircraft approaching from the side, may be critical. This, of course, is a key peripheral visual function whose importance is recognized. The purpose of several studies reported here was to investigate the effects of smoking on several types of tasks involving detection and recognition of movement by means of peripheral vision. Additional research was conducted dealing with the effects of smoking on a task involving the central visual field, i.e., the effects of smoking on time estimation.

The first investigation in the series was concerned with the effects of smoking and smoking deprivation on ability to detect movement in the peripheral visual field under high and low illumination conditions.

Twenty-five male subjects, 15 smokers and 10 non-smokers were screened for visual and physical defects. Subjects who were categorized as chronic smokers (20 or more cigarettes per day) were tested under a (1) smoking - high illumination condition, (2) smoking - low illumination condition, (3) smoking deprived - high illumination condition, and (4) smoking deprived - low illumination condition. Subjects categorized as nonsmokers were tested under a high illumination condition and a low illumination condition. All subjects reported to a subject lounge three hours in advance of each scheduled session. During this three hour waiting period, smokers were given a cigarette every 20 minutes and deprived smokers were not allowed to smoke. If a subject was in a low illumination condition, he was dark adapted during the last 20 minutes of the waiting period. All experimental conditions were assigned on a random basis with at least 24 hours separating each session. All subjects were given a one hour training session the day before their first scheduled experimental session and were paid for their participation.

During each session a subject was required to perform three tasks designed to measure (1) visual field based on an ascending and descending series of trials involving a moving target, (2) peripheral movement detection involving the ability to detect movement of a briefly displayed peripheral target, and (3) velocity estimation which required the subject to observe a moving target in the periphery, estimate its velocity, and predict its interception with a stationary target. Order of presentation of the three tasks was randomized with each task requiring 20 minutes. Subjects in the smoking condition smoked a cigarette during each of three 10-minute break periods during the test session. Depending upon the experimental condition involved, a subject was tested under either a low or high level of illumination.

Analysis of the data revealed no significant differences between smoking and smoking deprived subjects for either illumination condition in regard to the visual field measures. A comparison of smoking and nonsmoking subjects, however, showed a significantly larger field for nonsmokers under the low illumination condition. For the movement detection task, smoking deprived subjects were significantly better than smoking subjects at detecting and responding to movement in the periphery, particularly when higher speeds of target movement were involved. These two groups compared to nonsmokers revealed no significant differences. Analysis of the data for the velocity estimation task revealed that subjects in the smoking deprived condition performed significantly better than subjects in the smoking condition under the low illumination condition. No smoker-nonsmoker differences were found for this task. Based on the results of this investigation, it appears that smoking does have an effect on several critical peripheral functions.

The second investigation in the series was designed to determine the relationship between nicotine dosage level and peripheral visual performance. To determine nicotine dosage effects, 12 smokers appeared

under conditions of (1) smoking - high nicotine, (2) smoking - low nicotine, and (3) smoking deprived. Ten nonsmokers were also tested and compared with the deprived smokers. Under all conditions the subjects reported to a lounge three hours prior to testing. If under a smoking condition, high or low nicotine cigarettes (2.5 mg. or 0.3 mg. nicotine) were administered at 20 minute intervals for the entire lounge period. All subjects were trained on the apparatus prior to their first experimental session. For all conditions, subjects were required to perform two tasks designed to measure (1) peripheral movement detection involving the ability to detect movement or non-movement of a peripheral target traveling at one of four velocities or zero, and (2) velocity estimation which required the subject to observe a moving target in his periphery, estimate its velocity, and predict its interception with a stationary target.

Analysis of the movement detection data showed high nicotine smokers significantly better able to detect zero movement trials than either the low nicotine or deprived smokers. Analysis of the four movement speeds and the velocity estimation data all yielded nonsignificant differences.

The third study was designed to determine the time/response characteristics of smoking in terms of onset, duration, and decay of effects. To determine the time/response characteristics of smoking, 40 subjects (20 smokers and 20 nonsmokers) were tested. Smokers were tested under conditions of smoking and smoking deprived. Subjects in both conditions reported to a lounge two hours prior to testing. The tasks used were the same as those in the prior study with some slight modifications. Upon entering the test room, initial baseline performance measures were taken for all groups. Following the baseline period, smokers were administered a single test session cigarette and all groups were given a series of trials separated into blocks.

Analysis of deviations from baseline for the movement detection task showed smokers superior in their ability to detect non-movement of the target. For the velocity estimation task, a significant smoking treatment-blocks interaction was found. These data suggest that smoking does have an effect on the processing of peripheral visual information.

The final investigations were conducted to determine the effects of nicotine on the processing of visually presented information. In both studies, 15 chronic smokers were tested under smoking and smoking deprived conditions, and 10 nonsmokers were tested as a control group. Subjects were deprived of smoking for two hours prior to testing. The test sessions consisted of 10 minutes of task performance, during which baseline measures were taken, followed by a 10 minute treatment period, during which a cigarette was given to subjects in the smoking treatment, and finally, approximately 45 minutes of task performance, during which post-treatment measures were taken.

In the first study, subjects were tested on a simple velocity estimation task, viewed in the central visual field. The results indicated that nicotine had an adverse effect on the ability of subjects to perform this task, but only under certain extreme conditions of object speed and viewing time. These results were compared to previous research where detrimental nicotine effects were found over a wide range of speed and concealment values when a similar task was presented peripherally.

In the second study, subjects were required to estimate the velocity of a moving target and fire ahead of it to compensate for the time lag in a projectile trajectory. The results again indicated that smoking and smoking deprived subjects differed only under certain speed and exposure time conditions, but in this case, the smokers actually performed better than the deprived smokers. It was suggested that the higher level of information processing involved in this task was not adversely affected by nicotine.

Based on the results of these studies, it would appear that smoking and smoking deprivation may, in fact, have some effects on peripheral visual functions related to movement detection. It would also appear that smoking may have some effect on time estimation performance. It is important to note, however, these effects are minimal and implications for real world situations are probably not particularly significant.

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